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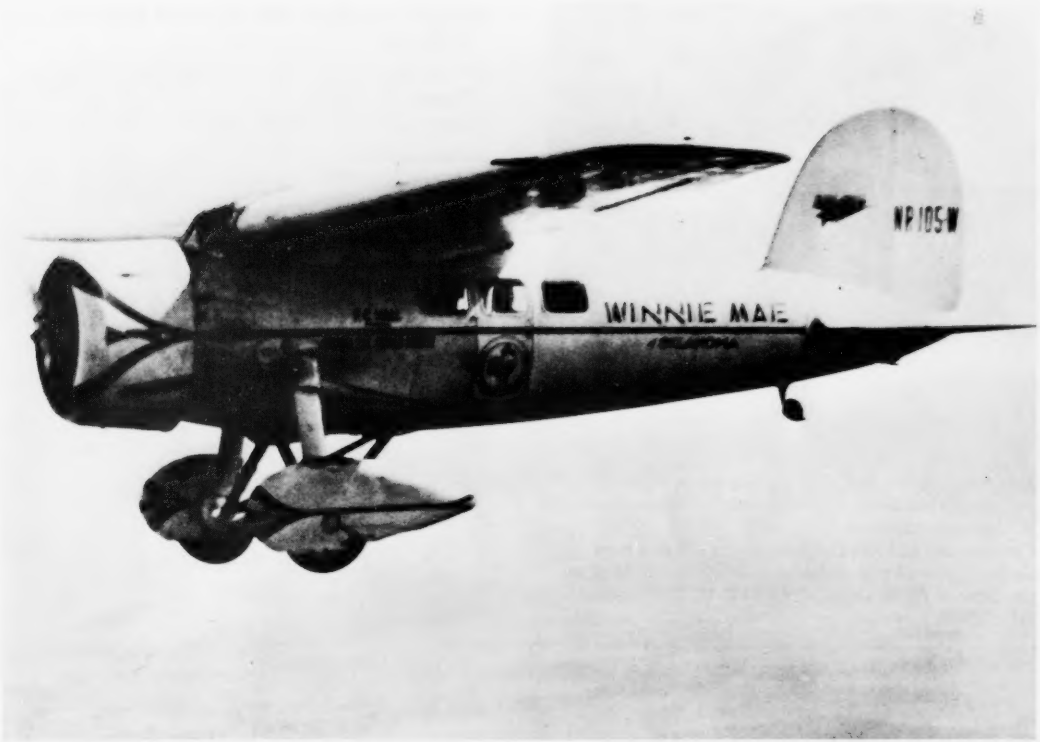

About the Cover

The "Winnie Mae", a Lockheed Vega, model 5B, flown by Wiley Post and Harold Gatty on their record round-the-world flight in 1931. The plane was painted white with purple and blue trim and had a Pratt and Whitney engine, number 3088, 420 horsepower. Their flight lasted 8 days, 15 hours and 51 minutes, a time more than 12 days faster than the previous round-the-world record set by the Graf Zeppelin in 1929. Both Post and Gatty received the Distinguished Flying Cross in honor of their achievement.

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Jacqueline McGowan
Acting Editor, Code LFD-10
NASA Headquarters, FOB 6
Washington, D.C. 20546
(Phone: (202) 755-8348)

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Post-Gatty Round-the-World Flight Recreated on 50th Annivesary

Three Oklahomans left New York on June 23 aboard a supercharged Beechcraft Bonanza aircraft to retrace the 1931 record round-the-world flight of Wiley Post and Harold Gatty. This date marks the 50th anniversary of the day Post and Gatty departed on their historic flight.

Aboard the Beechcraft are Dr. Kenneth E. Wiggins, crew member, and chairman of the Oklahoma Governor's Advisory Committee on Air Space Education and a nationwide coordinator of NASA's program on Air Space Education; Calvin Pitts, pilot, a fully-rated flight instructor and test pilot and a NASA Ames Research Center employee who conducts an agency-sponsored lecture program nationwide on the state-of-the-art in general aviation; and Joe Cunningham, navigator, also a pilot who has his own public relations firm and is a member of the Oklahoma Aeronautics Commission and serves as a publicity consultant to the Oklahoma Air Space Museum, Oklahoma City.

The threesome flew a 1980 A36TC supercharged Beechcraft Bonanza equipped with weather radar and oxygen. The new airplane, although highly sophisticated, has the same general performance characteristics as Post's Lockheed Vega. Post and Gatty's aircraft was named the "Winnie Mae" for the daughter of F.C. Hall, the financial backer of their 1931 flight round the world. The crew of the Bonanza named their craft the "Spirit of Winnie Mae."

The Post-Gatty round-the-world flight set a new world aviation record in 1931; their flight, from June 23 to July 1, lasted 8 days, 15 hours and 51 minutes, 12 days faster than the previous record. They covered 15,474 miles in 207 hours and 51 minutes,

The 1980 supercharged Beechcraft Bonanza which was used by Wiggins, Pitts, and Cunningham on their 50th anniversary recreation of the historic 14-stop round-the-world flight of Wiley Post and Harold Gatty, set in 1931. The three Oklahomans set out from New York on June 23, the same day Post and Gatty began their record flight, 50 years earlier.

averaging 146 miles per hour and spent 107 hours and 2 minutes in the air. In the 14 stops on the world trip, the Winnie Mae consumed 3,455 gallons of fuel.

Post and Gatty started their around-the-world flight at 4:55 p.m., EDT, June 23, 1931, from New York. They had $34 between them. Seven hours later they touched down at Harbour Grace, Newfoundland. Three hours and 43 minutes later they departed for England.

Gatty gave Post an ETA (estimated time of arrival) over Ireland. Post landed at an RAF base called Sealand Aerodome, near Liverpool. After lunch they flew on to Hanover. To his embarrassment, Post took off without checking his fuel gauges and had to return to Hanover for fuel.

The pair's next stop was Berlin where they received an enthusiastic welcome. They left Berlin early on June 25 and flew to Moscow—nearly 1000 miles through their worst encounter with weather so far on the trip. Gatty directed them to a landfall north of Moscow on the Volga River. Then it was on to Novosibirsk in central Russia at 176 mph ground speed. After celebrating most of the evening at the insistence of their Russian hosts, they departed Novosibirsk at 4:45 a.m., off for Blagoveshchensk in Siberia.

After a short refueling stop in Irkutsk, they flew on to Blagoveshchensk and landed in two inches of water standing all over the airport. Post taxied the Winnie Mae to a stop and knew he was stuck in the mud. He was within 300 miles of being across Siberia. More than 14 hours passed before the two were airborne again. The next leg to Khabarovck was without incident.

Making up for lost time, Post and Gatty flew nonstop on to Alaska near the village of Solomon—17 hours through rain and clouds. Post added only enough fuel for the flight to Fairbanks, 500 miles away. As they taxied out, the Winnie Mae sank into soft sand. The prop was bent before he could get the engine down. Post hay rigged the prop straight but when Gatty tried to prop the engine, it backfired and the prop hit him on the shoulder knocking him to the ground. Fortunately it was nothing more than a painful bruise. Only minutes later, they were off.

At Fairbanks they slept for three hours while a new prop was installed and the airplane was fueled. Crossing the cloud-covered Canadian Rockies was tiring. After Gatty declared they were past the mountains, Post began a slow, cautious descent. They broke out above the Canadian National Railway and followed it into Edmonton, where as in Siberia, this airport surface was covered with water. Post made the landing safely, but the takeoff seemed impossible until a Canadian Airmail Pilot suggested a take-off from Portage Avenue, a paved thoroughfare two miles long. Overnight, electric cables were removed from poles beside the road. It was a tight squeeze. Post later admitted he was a little scared himself. But he made a perfect takeoff and they flew on, uneventfully, to Cleveland where they touched down at 5:15 p.m. The crowds were just a sample of what was to come. They were only on the ground one-half hour and then departed for their final three-hour flight to New York.

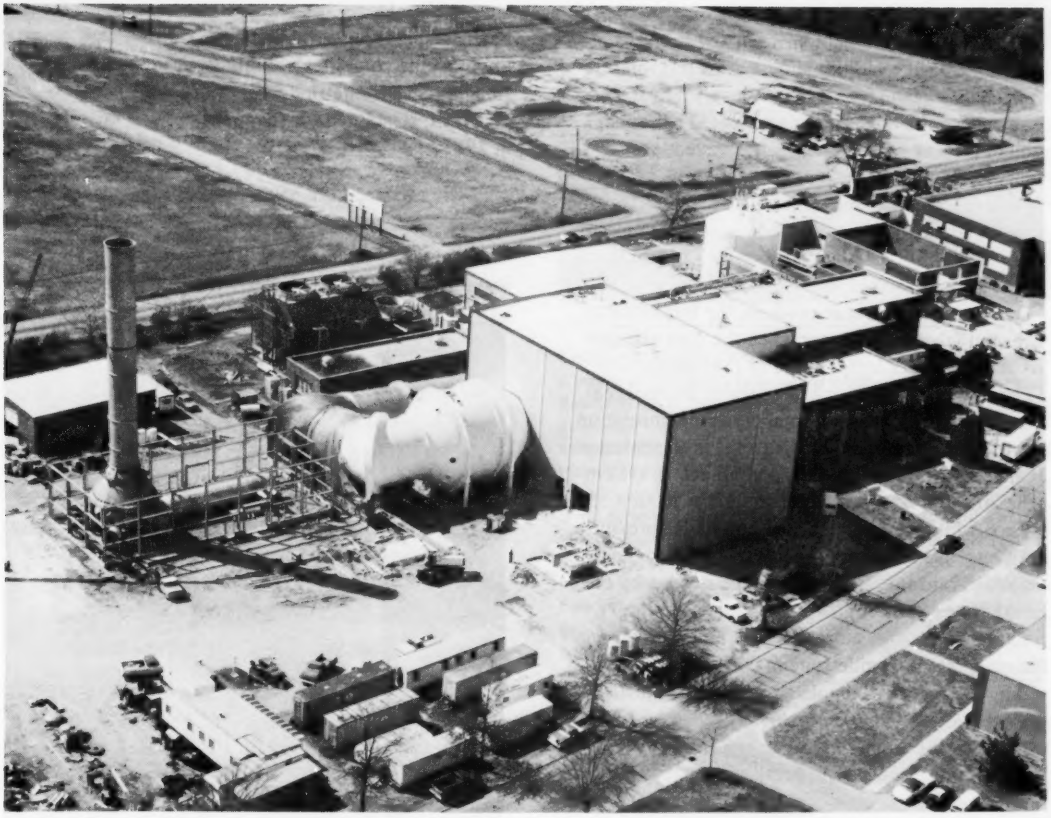
Post and Gatty landed in New York on July 1, 8 days, 15 hours and 51 minutes after setting out from this point. Pandemonium broke loose when they stepped from the plane, Post recalled. The wild excitement lasted for several days and included a ticker tape parade along Broadway that rivaled even Lindbergh's.

Editorial Note: The chronicle-of-events information on the Post-Gatty 1931 flight was supplied courtesy of the Oklahoma Air Space Museum, Oklahoma City.

Langley's New Cryogenic Wind Tunnel Nears Completion

By mid-1982, NASA's Langley Research Center, Hampton, Va., will have operational a unique wind tunnel, the National Transonic Facility, that utilizes cryogenic gaseous nitrogen to simulate air flow conditions of flight in the transonic range (speeds just below and above the relative speed of sound—Mach 0.8 to Mach 1.2).

Existing wind tunnels cannot accurately provide design information for aircraft that must fly in the transonic range—and almost all aircraft must pass through this range. Before the cryogenic concept, the traditional method of simulating transonic flight conditions on a wind tunnel model had been to increase the tunnel's air pressure. This method, however, also increased power, cost and loads on the model, causing unwanted distortion. A tunnel large enough to accommodate full-scale aircraft at transonic



NASA Langley Research Center's new National Transonic Facility, a transonic pressure wind tunnel scheduled for completion in mid-1982. The tunnel's entire pressure shell has recently been completely enclosed within the building at right center. The new wind tunnel will use gaseous nitrogen as a test medium to study aircraft in the transonic speed range.

speeds would require the power equivalent of several aircraft carriers to drive it and would cost well over a billion dollars.

With the cryogenic concept, both the general air flow (free stream) about a model and the thin air flow on a model's surface (the boundary layer) can be fully duplicated at the same time in a practical-sized wind tunnel. In addition, with temperature as a test variable, the National Transonic Facility will permit clear separation of aeroelastic, Mach number and Reynolds number effects on the aerodynamic performance of different aircraft models. The ability to separate these effects has not been possible using conventional ground facilities.

The National Transonic Facility's test section measures 8.2 feet in cross section and 25 feet in length. It will operate at high pressures (up to 130 psia) and at extremely low temperatures (down to −195 degrees Celsius). The estimated cost of the Langley facility is $80 million.

The primary advantages of using extremely low temperatures in wind tunnels was first conceived during the mid-1940s, but practical application of the principle was not proved until a pilot cryogenic tunnel was built at Langley in the early 1970s.

In the National Transonic Facility, cryogenic liquid nitrogen is introduced from storage tanks into the tunnel's injector system where it is converted into a super-cold mist. In the tunnel, the mist instantaneously changes to a gaseous form because the tunnel's temperature is warmer and under a lower pressure than the cryogenic fluid.

Fan systems within the tunnel structure are constantly drawing in ambient air to mix with the gaseous nitrogen. Additional fans draw this mixture out of the tunnel and up a 120-foot-tall vent stack for release to the outside environment. The tunnel's ambient air and gaseous nitrogen is mixed thoroughly as it travels up this stack so that the gas released is an environmentally safe discharge. The injector system works in conjunction with these fans to maintain a constant temperature and pressure within the tunnel.

The height of the stack prevents the formation of a fog cloud that could occur when the cold nitrogen strikes the warmer temperature of the outside air.

The tunnel's design includes several unusual features, among which are internal cryogenic insulation that may help dampen the noise level in the gaseous stream throughout the tunnel, and an access system to the aircraft test models that will allow models to be serviced while the tunnel is cold and under pressure.

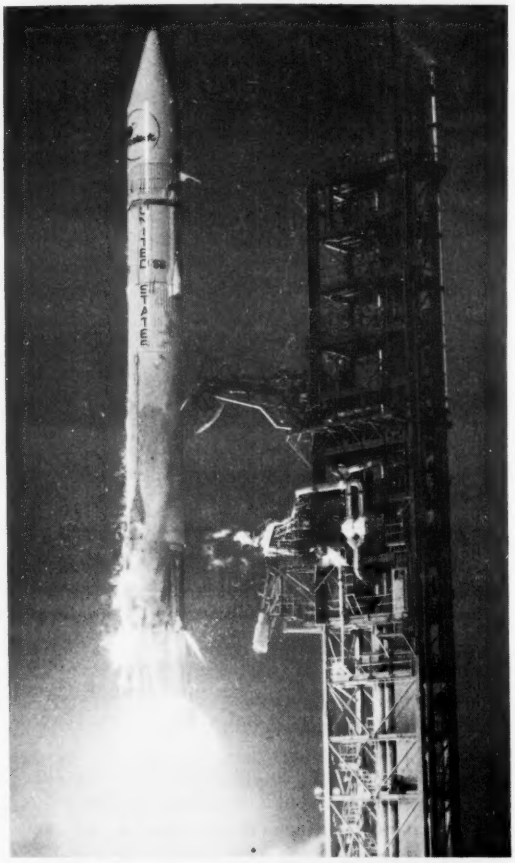
An improved research facility such as Langley's National Transonic Facility is vitally needed by the United States to meet growing demands for larger, more maneuverable, more complex and more energy-efficient aircraft. A milestone in construction of the facility was recently completed when the tunnel's entire pressure shell was completely enclosed. Construction of the facility began in 1975.

The National Transonic Facility's capacity for continuous operation, in conjunction with a high-speed data acquisition system, also will provide a high level of productivity for the new tunnel.

First Acceptance Review for Spacelab Simulator Conducted at Marshall

The first in a series of acceptance reviews of NASA's Marshall Space Flight Center Spacelab experiment simulator was recently conducted at the center. The simulator, an integral part of Marshall's high-fidelity Spacelab mission 1 mockup, will be used in training the payload crew to operate certain Spacelab experiments.

The simulator, which includes the front panels of Spacelab 1 experiment racks in the habitable module, and computer hardware and software, is designed to react to payload crew inputs as would the actual flight experiment hardware. It will provide the crew with the same feedback they would receive when operating the experiments in space. It will not only simulate normal experiment operation, but will also simulate problems and react to incorrect inputs from payload specialists. The first acceptance review involved the computer's ability to simulate "An Imaging Spectrometric Observatory," a NASA experiment, scheduled for the first Spacelab mission in 1983.



Fourth Expendable Launch Successful—NASA's fourth expendable launch for 1981, Intelsat V-B, the second in a series of nine international telecommunications satellites, successfully lifted off May 23 from the Eastern Space and Missile Center, Fla. Carried by an Atlas Centaur vehicle, liftoff occurred at 6:42 EDT. The spacecraft will have a final operating position over the Atlantic Ocean 35,792 kilometers above the equator.

Space Telescope Mirror Shaped and Polished

Shaping and polishing of the 2.4-meter primary mirror for NASA's Space Telescope has been completed at the Danbury, Conn., facility of the Perkin-Elmer Corp. The mirror surface has been completed to a perfection that deviates, at any point on the surface, less than one-millionth of an inch from an ideally perfect surface.

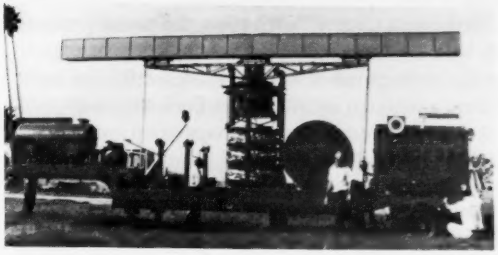
The primary mirror is the major optical component of the Optical Telescope Assembly, a major element of the Space Telescope. The Space Telescope Project is managed by NASA's Marshall Space Flight Center, Huntsville, Ala. Perkin-Elmer is prime contractor for the Assembly.

The 10-ton unmanned telescope will be placed in Earth orbit in early 1985 by the Space Shuttle and will have a mean orbital distance of 500 kilometers, putting it well above the interfering haze of Earth's atmosphere. It will enable man to gaze seven times farther into space than now possible—as much as 14 billion light-years—and to observe some 350 times more volume of space.

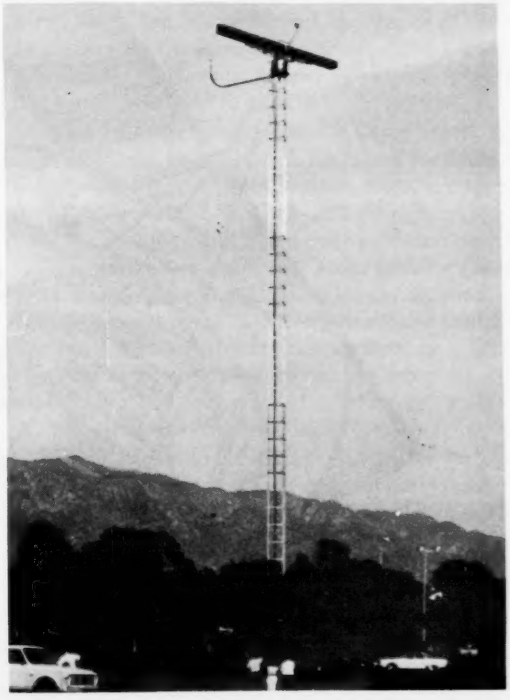
To take full advantage of this undistorted view of space, the telescope optics had to be polished to a much higher accuracy than those used in Earth-bound telescopes. Space Telescope's primary mirror was polished to specifications finer than for any previous telescope mirror its size, according to Perkin-Elmer.

The Space Telescope is of an optical design known as Ritchey-Cretien, a folded system with a secondary mirror in front of the primary mirror and the image plane behind the primary mirror. Every photon striking the primary mirror's eight-foot clear aperture will be reflected onto the secondary mirror, then focused at a point no bigger than one-quarter the diameter of a human hair. What this surface fineness means to astronomers is that they will see stars and galaxies 1/50th as bright as can be observed from Earth's surface.

Manufacture of the primary mirror blank began at Corning Glass Works, Corning, N.Y., in Oct. 1977. The blank was delivered to Perkin-Elmer a little over a year later, in Dec. 1978. Optical fabrication began with rough grinding of the front and back surfaces and of the inside and outside edges of the mirror shape. This was followed by fine polishing of the mirror front surface, using a specially developed computer controlled polisher and extensive data



Collapsible towers—During the sixties, NASA needed a a means of orbiting a large radio telescope antenna. Astro Research Corp., Santa Barbara, under a NASA contract developed a new type of structure that was strong, lightweight, folded into a small storage space and could be erected by rotation. The Astromast tower consists of tubular aluminum alloy and stainless steel members that deploy into small three-sided bays. Each of these are made rigid by six diagonal cables. All joints are flexible to permit folding and unfolding. The tower packs into a container only five percent of its height, can be erected without tools and is reusable. Possible spinoff applications of this technology developed for NASA include portable emergency bridges and commercial scaffolding.



reduction computer software, which began in Aug. 1980.

In the next stage of fabrication, the primary mirror will have two extremely thin, yet uniform, coatings applied to its polished surface. First, a reflective layer of pure aluminum .00002 inches thick will be applied and then a protective layer of magnesium fluoride .000006 inches thick which will prevent oxidation of the aluminum.

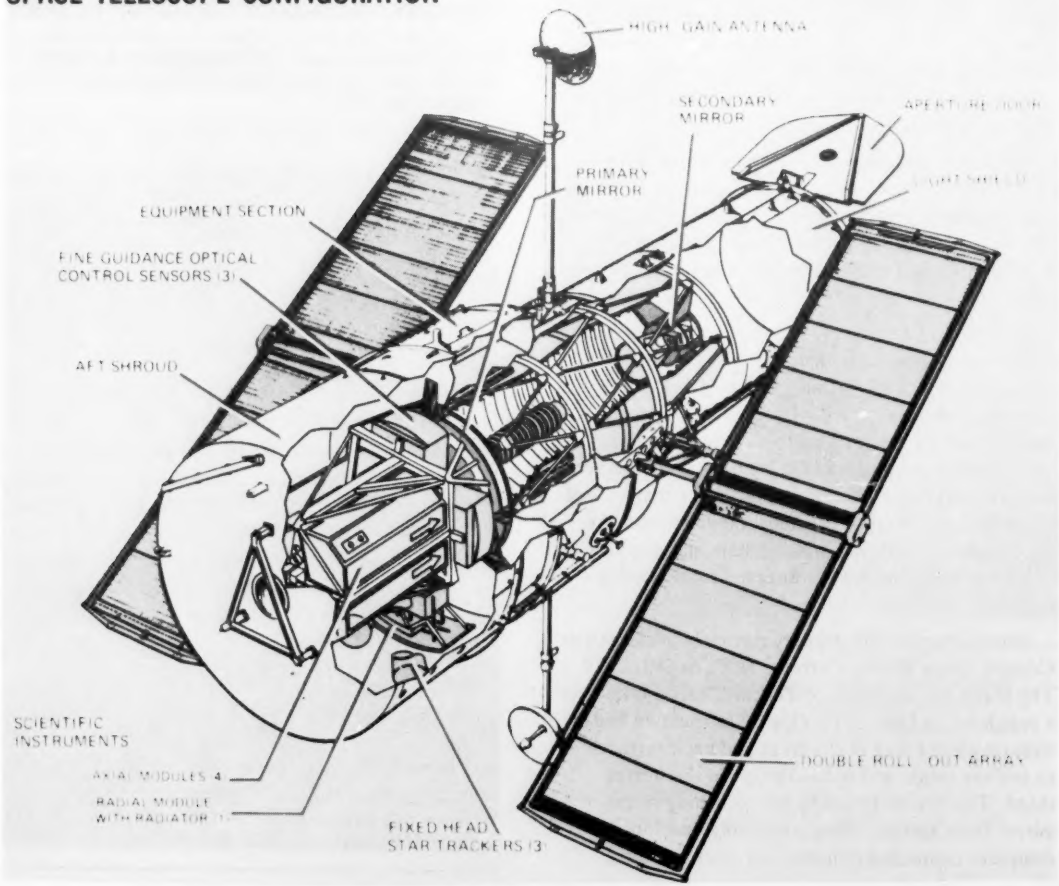
The coating operation will take place at Perkin-Elmer in a specially designed all-stainless-steel vacuum chamber constructed by Mill Lane Engineering Co. of Burlington, Mass. It is the largest chamber of its kind in the world and operates at a vacuum very near that of space.

After coating, the mirror will be installed in the Optical Telescope Assembly and aligned to the secondary mirror, focal plane and scientific instruments. The completed Assembly will then be integrated into the Support Systems Module and tested in its final flight configuration.

Giacconi to Head Space Telescope Institute

Dr. Riccardo Giacconi was named as first Director for NASA's Space Telescope Science Institute, Baltimore, Md., effective Sept. 1. John M. Teem, President of the Association of Universities for

SPACE TELESCOPE CONFIGURATION



Research in Astronomy, Inc. (AURA) made the announcement. AURA is the NASA contractor selected to operate and manage the Institute which will be the science nerve center for NASA's Space Telescope scheduled for launch in 1985.

Giacconi, chosen after a four-month search, now is Associate Director of the High Energy Astrophysics Division of the Harvard/Smithsonian Center for Astrophysics, Cambridge, Mass., and Professor of Astronomy at Harvard University.

Giacconi was selected from a field of some 60 possible candidates by the Space Telescope Institute Council, an AURA board committee headed by Dr. E. Margaret Burbidge, Professor of Astronomy at the University of California at San Diego and currently President-Elect of the American Association for the Advancement of Science (AAAS). This oversight council consists of 12 astronomers and administrators, including seven members of AURA's Board of Directors and two astronomers from institutions in European Space Agency (ESA) member nations. (ESA is providing the solar power array panels and one of five instruments for the Space Telescope, as well as some scientific and other staff for the Institute.)

Giacconi received a degree in physics at the University of Milan in 1954. His thesis work was on nuclear interaction by cosmic rays. He was awarded a Fulbright Fellowship and continued his work in elementary particles at the University of Indiana, Bloomington, and at Princeton University in 1959.

He joined American Science & Engineering, Inc., in 1958, to initiate a program of space science, and there became interested in X-ray astronomy. In 1962, Giacconi's group succeeded in detecting the first extrasolar X-ray source. In 1963, the same group obtained the first solar X-ray picture by use of an X-ray telescope which had been conceived, advocated, designed, fabricated and tested by them.

In 1963, Giacconi proposed an X-ray astronomy explorer. The proposal led to a program of construction in 1966–70, followed by successful launch in 1970. The satellite became known as Uhuru and represented a major qualitative step in X-ray astronomy's observational capability.

In 1970, the program for construction of a 1.2 meter X-ray telescope for study of extrasolar sources was initiated. The program was modified in 1973 and finally led to the High Energy Astronomical Observatory, HEAO-2 (Einstein Observatory) mission, successfully launched in 1978. In 1973, Giacconi joined the faculty of Harvard University and became an Associate Director for the Center for Astrophysics, High Energy Astrophysics Division.

Among the most significant activities of the Division have been the scientific direction of the HEAO-2 Program. While this mission was conceived and executed as a Principal Investigator experiment, the observatory was used as a national facility by a large number of astronomers. In its lifetime it reached a level of community involvement comparable to that at a major groundbased national center. Giacconi served as Principal Investigator during the conception, design and fabrication phase of HEAO-2 and currently is acting as Director of the Observatory.

The Association of Universities for Research in Astronomy, Inc., a consortium of 16 universities, is under contract with NASA to establish and operate the Space Telescope Science Institute. This major astronomical research center, where astronomers will receive data electronically from the orbiting Space Telescope and its five instruments, will be housed in a yet-to-be-constructed building on the campus of The Johns Hopkins University in Baltimore. AURA also is funded by the National Science Foundation to manage the operation of the Kitt Peak National Observatory near Tucson, Ariz., the Carro Tololo Inter-American Observatory in Chile, and the Sacramento Peak Observatory in Sunspot, N.M.

The 239-centimeter aperture NASA Space Telescope is already two-thirds built under the direction of the Marshall Space Flight Center, Huntsville, Ala., with the support of the Goddard Space Flight Center, Greenbelt, Md. Scheduled for launch from the Space Shuttle in early 1985, it will be put into orbit 500 kilometers above the Earth and will radio its signals through the NASA communications network to Goddard and then to the Institute. An arm of the Institute to be known as the Science Support Center will be located at Goddard. The center will coordinate directly with the Goddard engineers and telescope operator who will translate the Daily Science Schedule (prepared by the center under Institute direction) into commands for the telescope. Observers at the Institute will communicate via intercom with the center.

NASA-Langley Storm Hazards Project F-106B aircraft which carries experiments designed to study the meterological and electrical environment of thunderstorms.

Langley Experiment Confirms Lightning Produces Environmentally Significant Gas

The term "ACE" means different things to different people, but to Dr. Joel S. Levine of NASA's Langley Research Center, ACE means flying into thunderstorms hoping to get struck by lightning. Levine does not fly into thunderstorms himself, but his ACE experiment does—to study the production of environmentally significant gases in lightning, such as nitrous oxide.

Levine's ACE, or Atmospheric Chemistry Experiment, is one of several experiments carried into thunderstorm cells aboard the NASA-Langley Storm Hazards Project F-106B aircraft to study the meteorological and electrical environment of thunderstorms. ACE is part of a continuing NASA program involving laboratory discharge experiments and theoretical coupled hydrodynamic-chemical shockwave calculations to assess the production and chemistry of environmentally significant trace elements in lightning.

Nitrous oxide is a significant gas for study because it leads to ozone destruction. It rises from the lower atmosphere, where it is primarily manufactured by microbiological processes in the soil, to the stratosphere, where it is chemically transformed to a gas that works to deplete the Earth's protective ozone layer. At about 24 kilometers above the surface of the Earth, the highly concentrated ozone layer absorbs lethal solar ultraviolet radiation, thus shielding the Earth. Lightning is far from being the most abundant source of nitrous oxide, but this gas, produced by lightning, is probably transported to the stratosphere very rapidly, due to strong convective motions within thunderstorms.

The Atmospheric Chemistry Experiment package consists of a series of 24 stainless steel collecting bottles that are individually activated on command of the airplane's copilot. The first samples of air exposed to lightning were obtained during the summer of 1980. These samples were analyzed for their nitrous oxide content using a gas chromatograph equipped with an electron capture detector. Preliminary analysis indicates that about one-third of the more than 100 thunderstorm samples showed nitrous oxide levels enhanced more than 10 percent above the background level. (The background level of nitrous oxide, based on analysis of samples obtained during clear air flights, was found to be 308 parts per billion (ppb), with a sample variability of less than eight percent.) One thunderstorm air sample had a level approaching 500 ppb, an enhancement of 60 percent above the background level. These measurements indicate a very non-homogeneous distribution of nitrous oxide within the thundercell.

These results, which constitute the first direct and unambiguous observations of the production of a trace gas by lightning, qualitatively confirm earlier laboratory measurements and theoretical calculations.

Yardley Leaves NASA to Head McDonnell Douglas Astronautics

John F. Yardley, NASA Associate Administrator for Space Transportation Systems, has been named president of McDonnell Douglas Astronautics Co., Division of McDonnell Douglas Corp., St. Louis, Mo. Effective June 1, L. Michael Weeks became Acting Associate Administrator for Space Transportation Systems. Yardley joined NASA in May 1974 as Associate Administrator for what was then called the Office of Manned Space Flight. In this position he was responsible for development and acquisition of the Space Shuttle, its upper stages, associated ground facilities and equipment and system improvements.

Yardley came to NASA from McDonnell Douglas Astronautics, where he was vice president and general manager of the Eastern Division. He joined McDonnell Aircraft Corp. in 1946 as a structural engineer and went on to become project engineer for Mercury spacecraft design, launch operations manager for projects Mercury and Gemini, and vice president and general manager for the Skylab project.

Yardley received NASA's Public Service Award for his contributions to the Mercury Program in 1963, and for the Gemini Program in 1966. He was awarded the Spirit of St. Louis Medal by the American Society of Mechanical Engineers. He is a fellow of the American Institute of Aeronautics and Astronautics and the American Astronautical Society and is a member of the National Academy of Engineering.

Marshall's Utility Control System Now Operating

In a major step toward improved energy conservation, NASA's Marshall Space Flight Center, Huntsville, Ala., has activated the first phase of the Utility Control System—an array of remote sensors and mechanisms tied to a central computer that automatically monitors and controls the heating, ventilation and air conditioning equipment throughout the Center.

When completed, the system will monitor and control the 45 largest of the Center's 200 buildings and facilities. "Out of 200 buildings," said Ed Demirjian, chief engineer for Marshall's Facilities Office, "45 of them—which is about 22 percent of the total facilities at Marshall—use 75 percent of the total energy consumed here. Placing these particular 45 buildings under the Utility Control System was the most cost-effective approach. We now have portions of three buildings connected to the system. By August, we plan to have the other 42 buildings on line."

The sensors of the control system monitor such conditions as temperature, indoor and outdoor humidity, kilowatts-per-hour electrical metering, steam consumption and chilled water pressure. If the sensors detect anything amiss, the computer will either correct the malfunction, make an adjustment to negate a problem trend, or alert the terminal operators that a piece of equipment has failed and requires attention.

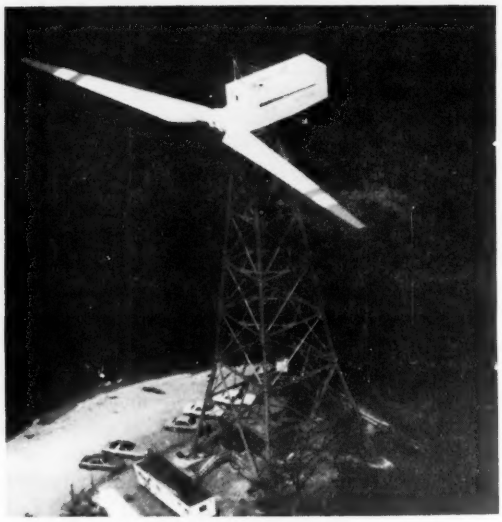
Total cost of the project, when completed, will be $1.2 million, but the system saves six million kilowatt-hours of electricity and 44 million pounds of steam each year. "That's a savings of $700,000 a year," said Demirjian. "The system pays for itself in less than two years."

NASA has a goal for all Centers to reduce energy consumption 50 percent below the 1973 levels. "Marshall Center has already reduced energy consumption by 48 percent during the last fiscal year," said Horton Webb, director of the Marshall Facilities Office. "When the Utility Control System is completely on line, it will save nearly three percent by itself, and that will put us over the 50 percent mark."

Nation's First Large Wind Farm Dedicated May 29

The nation's first large experimental "windfarm," consisting of three machines, each producing 2.5 megawatts was officially dedicated on Friday, May 29, at Goodnoe Hills, Wash. Business, community and government leaders throughout the country gathered to mark the first operation of all three machines as a cluster.

Designated Mod-2 (Model 2), these machines are designed to produce competitively priced electric energy if built on a volume basis. The Mod-2 is currently the most advanced in a series of horizontal axis wind turbines developed for the Department of Energy by NASA's Lewis Research Center, Cleveland. Boeing Engineering and Construction Company of



The world's largest wind turbine at Howards' Knob, Boone, N.C. This turbine produces electric power for approximately 500 homes and has a rated power capacity of 2,000 kilowatts. The blades reach 61 meters from tip to tip and rotate in wind speeds from 18 to 56 kilometers per hour.

Seattle designed, built and installed the large machines. The Bonneville Power Administration provided the site and utility interconnection and is participating in the testing and operations of the three wind turbines.

The Mod-2 is designed to generate electricity in windy areas at a cost equal to or less than conventional oil-fired electric power generation. If these machines were to be produced in quantities of 100 per year or more, the 100th wind turbine and those following would provide energy at a cost of less than 5 cents per kilowatt hour.

The three machines at Goodnoe Hills are set up in a triangular pattern, ranging from 457 to 914 meters apart. NASA engineers predict that "farms" of 25, 50 or more such wind turbines may be producing truly significant amounts of cost-effective electricity by the end of the century.

Each wind turbine has a 91-meter diameter rotor equal to the length of a football field. The rotor and the nacelle which houses the machinery and generator are mounted on a 61-meter tall tubular tower. Each produces 2.5 megawatts at wind speeds of 32 kilometers per hour or greater, for a combined output from the cluster of 7.5 megawatts.

Once the wind turbines complete engineering acceptance tests, a two-year operational field testing program will begin which will examine all aspects of the machines and their operation and performance.

The Mod-2 project is part of a broad-ranging federal research and development effort in wind energy. Several earlier experimental wind turbines in the 100 to 200 kW power range and one at 2000 kW have been under test at a number of utilities the past several years. The Department of Energy also sponsors development of small wind turbines of up to 40 kW for residential, agricultural and small industrial users, and has supported research into and measurement of wind resources for utility and private applications.

Voyager 2 Reenters Tail of Jupiter Enroute To Saturn

NASA's Voyager 2 has returned to the environment of Jupiter, almost two years after it flew past the planet. Heading for a rendezvous with Saturn in late August this year, Voyager 2 has encountered the magnetic tail of Jupiter extending almost 482 million kilometers beyond the giant planet—and the end isn't yet in sight.

Dr. Frederick L. Scarf, a TRW Inc., Redondo Beach, Calif., scientist and principal investigator for Voyager's Plasma Wave instruments, and his colleagues, Dr. Donald Gurnett and Dr. William Kurth of the University of Iowa, where the instrument was built, detected noises in plasma wave measurements obtained in February 1981 that were identical to those last heard in July and August 1979, when Voyager 2 was departing Jupiter but still in that planet's magnetosphere. From this new information, they determined that Voyager 2 passed through a filament of the Jovian magnetotail a year and a half after leaving the planet.

As Voyager moves toward its meeting with Saturn, both Saturn and the spacecraft should cross into the Jovian magnetotail, or wake, about 628 million km beyond Jupiter. This alignment of Saturn in the expected region of Jupiter's tail happens only once every 13 years, and Voyager 2 will be in a nearly perfect position to investigate the phenomenon. Jupiter's magnetosphere, like Earth's is shaped

like a teardrop, but its size is enormous compared to Earth's. As the solar wind streams past the planet, it blows the huge magnetic globe into a tail that points away from the Sun.

Several years ago, Scarf suggested that Jupiter's magnetotail might extend all the way to Saturn. He pointed out that the rare outer planet alignment that made the multi-planet mission possible would also lead to a nearly simultaneous alignment of Voyager 2 and Saturn in Jupiter's tail.

Scarf published his ideas in the Journal of Geophysical Research in 1979, before Pioneer 11 made the historic first visit to Saturn and confirmed the existence of a Saturnian magnetosphere.

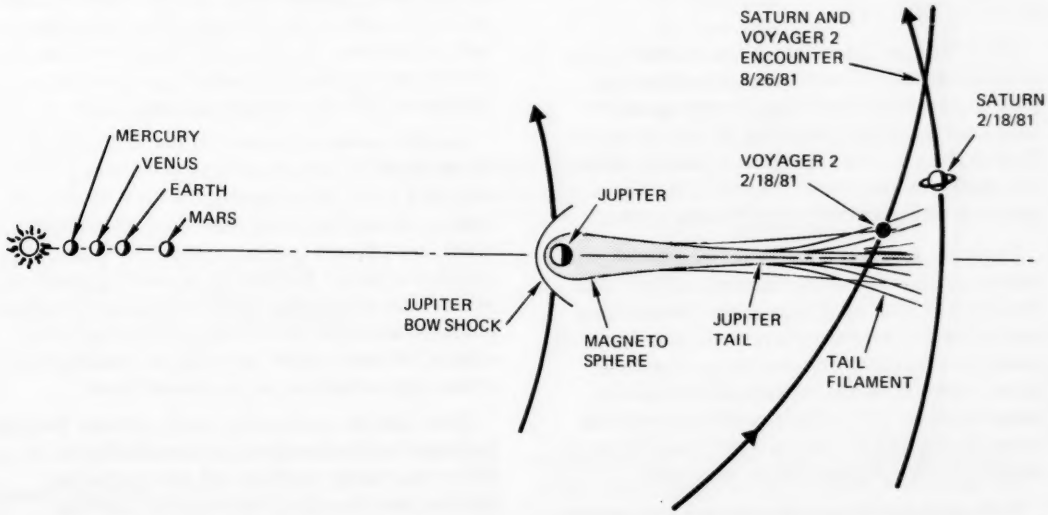
He predicted that: "Voyager 2 may remain in the Jupiter magnetosheath-bow shock region for an extended time and the spacecraft may well interact with the distant tail in 1981. Saturn itself may be immersed in the tail of Jupiter during comparable periods in 1981."

Kurth found confirmation of Scarf's 1979 prediction recently, when sifting through Voyager 2 plasma wave data obtained in February 1981.

"The way we tell we're in the tail," Scarf explains, "is that we see noise in a certain range of frequencies that is characteristic of Jupiter. In data we received from Voyager earlier this year, we saw exactly the same characteristics we last saw as we were leaving Jupiter a year and a half before. We are convinced that we were experiencing Jupiter's magnetosphere again."

Scarf contacted Dr. Herbert Bridge and Dr. James Sullivan of Massachusetts Institute of Technology, Cambridge, scientists on the Voyager plasma probe that measures plasma streams from the Sun that form the solar wind. They told him they had not seen any solar plasma during that part of February—that the solar wind did not flow past the spacecraft then. That confirmed Voyager 2 was in the Jovian tail for at least those few days in February.

"We now know that Jupiter, the Earth and comets have extremely long magnetic tails," said Scarf, "caused by the solar wind stretching their magnetic fields out over enormous distances. A comet's tail is luminous and can be seen. Jupiter's tail is not. The only way we can be certain that planetary tails exist



Sketch showing Voyager 2's trajectory from Jupiter to Saturn, the Jovian bowshock, magnetosphere, and newly confirmed extended magnetotail stretching out toward the orbit of Saturn. (Distribution of planets in this sketch is approximately to scale—Saturn is almost as far from Jupiter as Jupiter is from the Sun.) On Feb. 18, 1981, Voyager 2 passed through a filament of the Jovian magnetotail. Jupiter is moving around the Sun faster than Saturn, and the main body of its tail should sweep across Saturn and Voyager 2 during the summer of 1981. Voyager and Saturn will meet on Aug. 26.

is to measure the absence of solar wind plasma and the presence of trapped radio waves.

"The magnetotail is like a magnetic hole in which the solar wind doesn't blow. It's affected by the orbital movement of the planet and the ebb and flow of the solar wind, and appears to flap or wag back and forth, with lots of filaments (like loose hairs) waving in the breeze.

"We're interested in understanding the energy that is stored in this region. We don't understand any of the processes that go on in a distant magnetotail. Comet tails flare up, and some scientists speculate that energy is stored in the tail and then returns to produce an aurora. We imagine similar things happen at Jupiter (or even in the distant tail of Earth), but we haven't yet explored those regions—we only know that there's an interaction between the tail and its planetary body.

"Some of the planetary plasma that is blown out in the tail could be recirculated by returning through the tail and affecting Jupiter. Energy accumulates in the tail region and a storm can develop internally—generally called a substorm. At such times, the stored energy will flare up, explode and return to the planet," concludes Scarf.

When Voyager 2 and Saturn cross Jupiter's magnetotail, the material within the tail and the interplanetary magnetic fields may be merging and the solar wind plasma may be filling the void of the tail. If those processes are in progress at Saturn's distance, information on the relative roles of solar plasma and planetary magnetic fields would become available.

Inside the Jovian tail, Saturn would encounter unusual conditions such as magnetotail wind rather than solar wind, or no plasma at all. The total pressure on Saturn's magnetosphere could drop drastically, leading to a weakening or even disappearance of Saturn's bow shock and inflation of the Saturnian magnetosphere. Those effects could be directly observed by Voyager 2 if Saturn is still immersed in the Jovian tail when Voyager arrives in August.

Until a few weeks ago, all of this was just speculation. Now it begins to look very real. The next Saturn encounter might be very different from the two before.

The Voyager project is managed for NASA by the Jet Propulsion Laboratory, Pasadena, Calif.

NASA Technology Provides Basis for Human Tissue Stimulator

NASA spacecraft technology has been transferred to medical applications that could revolutionize treatment of pain, involuntary motion and nervous disorder. This technology of miniaturized microcircuitry was developed at NASA's Goddard Space Flight Center, Greenbelt, Md., and was proven in a decade of space exploration from 1962–72. The transfer of this technology to medical applications was developed by scientists at The Johns Hopkins University Applied Physics Laboratory, near Columbia, Md.

Johns Hopkins engineers utilized design criteria from the 181-kilogram Small Astronomy Spacecraft-C to reduce the spacecraft systems to a deck-of cards size. The size of this compact circuitry provides surgeons with an electronic device which can be implanted in patients suffering from neurological disorders or damage. Compression of this proven technology into modern neurological surgical techniques provides a unique, discrete and direct new approach to the relief of intractable pain and uncontrollable tremors.

In the manner of spacecraft ground controllers sending radio commands to a satellite, neurosurgeons are able to address the implanted Tissue Stimulator with an electronic digital signal. These signals are the doctor's description in the form of pulses to the problem area for the desired stabilizing result.

The SAS spacecraft series (A, B and C) revealed the existence of such phenomena as quasars, pulsars and black holes, while carrying out their missions of seeking information in the gamma ray, ultraviolet, visible and infrared spectral regions both inside and outside our galaxy. Because of the required compactness of onboard systems, Goddard spacecraft designers produced advanced state-of-the-art electrical power sources, telemetry uplink-downlink methodology and secure logic techniques not previously flown.

Other features, such as the nickel cadmium batteries developed by Goddard designers specifically for the SAS series, charge regulator and monitor for the batteries, and the secure logic circuitry allowing NASA ground controllers to store commands in the spacecraft memory for functions to be performed beyond ground station control range, were reduced to microminiature (100-to-1 ratio) proportions by the Applied Physics Laboratory engineers and incorporated into the Tissue Stimulator design.

NASA-Sponsored Development Opportunities

NASA supplements employee development efforts by sponsoring a number of internal and external fellowship, work experience, and training programs for selected employees whose performance has demonstrated management ability. The annual cycle for selection is underway. Your local training office has program information, nomination procedures, and local suspense dates. The table below lists those programs which are available.

Title	Length	Nomination due in Hq
Fellowships		
MIT–Sloan	3 semesters	10-1-81
MIT Advanced Engineering/Science	1 semester	10-1-81
Stanford–Sloan	2 semesters	10-1-81
Education for Public Management	2 semesters	10-1-81
Hugh L. Dryden Memorial	2 semesters	10-1-81
Carnegie-Mellon Public Education	4–5 weeks	10-1-81
Harvard Advanced Management	13 weeks	10-1-81
Harvard J.F.K. Program for Senior Executives	13 weeks	10-1-81
Harvard Program for Management Development	14 weeks	10-1-81
Syracuse Maxwell Midcareer	1 semester	10-1-81
Simmons Middle Management	10 weeks	10-1-81
Work Experience Programs		
Executive Development Work Experience	12 mos. max.	Negotiable
SES Candidate Development	12 mos. max.	2-15-82
Career Development Program	12 mos. max.	2-15-82
Critical Assignment Development Program	12 mos. max.	Negotiable
President's Executive Exchange	12 mos. max.	2-15-82
Management Education Center Wallops Island, Va.		
Executive Seminars	To be determined	
Management Education Program (MEP)	2 weeks	
MEP Follow-On Seminars	3½ days	
Project Management Shared Experience	1–2 weeks	

Awards Corner

Dr. Robert Thomas Jones, senior scientist at NASA's Ames Research Center, Mountain View, Calif., was awarded the distinguished **Langley Medal** by the Smithsonian Institution for his "extensive contributions in theoretical aerodynamics, particularly with regard to development of the swept wing, supersonic area rule and, more recently, the oblique wing." The Langley award has been given to just 16 recipients since it was established 73 years ago. Past recipients include Wilbur and Orville Wright, Colonel Charles Lindbergh and Rear Admiral Richard Byrd. Named for Samuel Pierpont Langley, aeronautical pioneer and third secretary of the Smithsonian, the medal honors "especially meritorious investigations in the field of aerospace science."

Charles E. Cataldo, Deputy Director of Marshall Space Flight Center's Materials and Processes Laboratory, has been elected a **Fellow of the American Society for Metals** by the Society's Board of Trustees in recognition of his distinguished contributions in the field of metals and materials. The Fellows provide a broadly based forum for technical and professional leaders to serve as advisors to the Society.

Two Langley Research Center researchers have been selected for the **Floyd L. Thompson Fellowship Program for 1981–1982. Dr. Stephen K. Park,** Analysis and Computation Division, will spend one academic year at the Optical Sciences Center of the University of Arizona where he will conduct research involving the mathematical and computational modeling of multispectral remote sensing systems for conceptual design studies and performance evaluation and the analysis and classification of multispectral image data. **Dr. Melvin S. Anderson,** Structures and Dynamics Division, will study at the University of Wales' Institute of Science and Technology and the University of Birmingham, England. He will develop practical, efficient and accurate structural analysis for very large structures proposed for future space application by taking advantage of their likely geometry, contruction methods and other factors that will result from being in the vacuum and weightlessness of space. The Thompson Fellowship Program was established in 1977 to encourage the development of research potential among the Langley staff. The Fellowship allows researchers who have demonstrated continued growth in research to spend up to 12 months at an educational or research institution. It is named in memory of Dr. Floyd L. Thompson, Langley Director from 1960 to 1968. Thompson joined the Langley staff in 1926, retired in 1968 and was a consultant to the NASA Administrator until January 1973.

Dr. Charles E. Billings, NASA-Ames Research Center, has been selected as the recipient of the **1981 Laura Taber Barbour Air Safety Award** by the Flight Safety Foundation, Inc., Arlington, Va. Dr. Billings was chosen for his contributions to aviation safety in the field of human factors and pilot error research. The Barbour Award citation also notes Dr. Billings' design and implementation of the FAA-Aviation Safety Reporting System, and his persistence in making it an operational system. The Laura Taber Barbour Award recognizes "notable achievement in the field of aviation safety—civil or military—in method, design, invention, study or other improvement." It was established in 1956 by the late Dr. Clifford E. Barbour, and his son, Clifford E. Barbour, Jr., in memory of Mrs. Laura Taber Barbour, wife and mother, who lost her life in an airplane accident in 1945.

Dr. Richard D. Johnson, chief of the Biosystems Division of NASA's Ames Research Center, has been named a **1981–82 Alfred P. Sloan Fellow** by the Massachusetts Institute of Technology. The 57 fellows chosen for the coming year will spend 12 months, beginning in June, studying for a master of science degree in management at M.I.T.'s Alfred P. Sloan School of Management. The Sloan fellows program, started in 1931, was the first executive education program in the nation. The idea of a full-year of study for mid-career executives was initiated by the late Alfred P. Sloan, Jr., former chairman of the board of General Motors Corporation, and the late Professor Erwin Schell of M.I.T. The 1981–82 class is the largest in the program's 50-year history. The class of mid-career executives includes fellows from 10 foreign countries and from a broad range of activities in the private and public sectors in such fields as health, education and government.

NASA presented medals and awards to members of the **Voyager project team** at the Jet Propulsion Laboratory, Pasadena, Calif., June 2. **The awards recognize nearly 10 years of effort,** including early project planning, mission and spacecraft design and development, launch, early flight operations and the highly successful encounters with Jupiter in 1979 and the Voyager 1 Saturn encounter in 1980.

The Voyager project, managed for NASA by the Jet Propulsion Laboratory, launched two spacecraft to Jupiter and Saturn in 1977. Voyager 1 encountered Jupiter March 5, 1979. Voyager 2 encountered Jupiter July 9, 1979. Voyager 1 flew past Saturn Nov. 12, 1980. Voyager 2 will make its closest approach to Saturn Aug. 25, 1981, and then will head for Uranus and possibly Neptune.

Receiving **Distinguished Service Medals were: Dr. Bruce C. Murray,** JPL director; **Raymond L. Heacock,** former project manager; **Harris M. Schurmeier,** former project manager: and **Dr. Edward C. Stone,** project scientist.

Those who received **Outstanding Leadership Medals** were: **John R. Casani,** former project manager; **Glenn E. Cunningham,** former spacecraft team chief; **Esker K. Davis,** project manager; **Michael W. Devirian,** former space flight operations director;

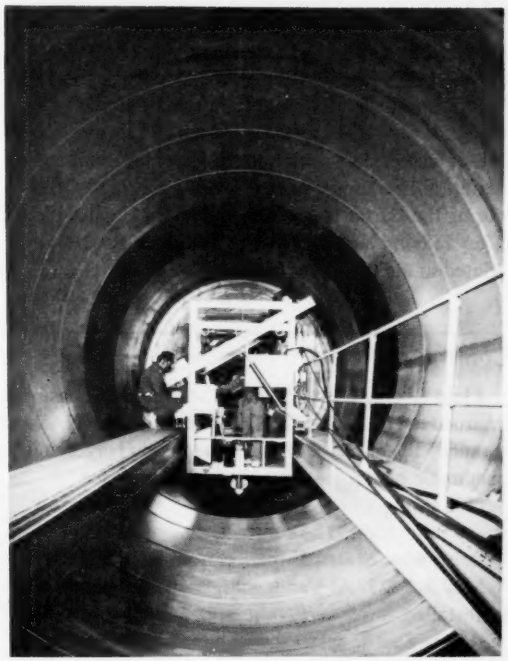
Ronald F. Draper, spacecraft systems engineer; **William G. Fawcett,** science instruments manager; **Charles E. Kohlhase,** mission planning office manager; **Richard P. Laeser,** mission director/deputy project manager; **James E. Long,** science manager; **Dr. Peter T. Lyman,** former deputy project manager; **Richard P. Mathison,** telecommunications science and engineering division manager; **Edward L. McKinley,** flight engineering office manager; **William S. Shipley,** spacecraft development manager; **Dr. Charles H. Stembridge,** flight science office manager; **Francis M. Sturms,** former sequence design and integration manager; and **George P. Textor,** deputy mission director.

Exceptional Scientific Achievement Medals were awarded to: **Dr. Andrew P. Ingersoll,** imaging science team; **Dr. Torrence V. Johnson,** imaging science team; **Dr. Arthur L. Lane,** assistant project scientist, Jupiter; **Dr. Gunnar F. Lindal,** radio science team; **Dr. Ellis D. Miner,** assistant project scientist, Saturn; **Dr. Frederick L. Scarf,** principal investigator, plasma wave experiment, TRW; and **Dr. Rochus E. Vogt,** principal investigator, cosmic ray experiment.

Did You Know?

Sixteen Langley Research Center inventors were recently honored for receiving U.S. patients in 1980: **Carmen E. Batten** (first woman who was the sole inventor of a contribution for which a patent has been issued), visible and infrared polarization ratio spectroreflectometer; **Roland W. Lee,** retainer for murine specimens and test equipment; **Randolph F. Culotta** and **Donald L. Posey,** static pressure orifice system testing method and apparatus; **Maynard C. Sanford** and **David L. Gray,** solar cell angular position transducer; **Wilford E. Sivertson, Jr.,** radar target for remotely sensing hydrological phenomena; **William R. Hood,** detection of the transitional layer between laminar and turbulent flow areas on a wing surface; **Emmett L. Bryant,** noncontacting method for measuring angular deflection; **David C. Grana** and **Richard T. Wilem,** natural turbulence electrical power generator; **Ronald N. Jensen,** combined solar collector and energy storage system; **Joseph S. Heyman,** CDS solid-state phase insensitive ultrasonic transducer; **William M. Kahlbaum, Jr.,** chromatically corrected virtual image visual display; **Dr. Wolf Elber,** partial interlaminar separation system for composites; and **Bobby L. Berrier,** thrust augmented spin recovery device.

Idea Clearinghouse calls attention to a new message transmitting and receiving system that was installed recently by the Communications Branch of NASA's Ames Research Center. The new system, known as Micronet 3, a product of Sidereal, Inc., provides improved capabilities not possible with the conventional teletype equipment it replaced. Messages can be transmitted nationally or worldwide in as many as eleven different formats and at speeds upwards of 1200 words a minute—far superior to the 100 wpm maximum of the old system. The input/output



Inside the Solid Rocket Booster—Workmen at Thiokol Corp., Wasatch Div., Brigham City, Utah, operate a roll dispenser tool in applying insulation to the inner surface of a solid rocket motor casting segment. The tool is stationary and the casting segment is turning. Each solid rocket motor consists of four segments with the nozzle installed in the aft segment and a nozzle extension shipped separately. NASA's Marshall Space Flight Center, Huntsville, Ala., add to the solid rocket motor a nose cone and frustrum which contains a parachute recovery system and separation motor module, a forward skirt, and aft skirt holding another separation motor module and two thrust vector control systems, cable tunnel, attach struts and electronic items which make up the solid rocket booster for the Space Shuttle.

module is almost entirely electronic which results in fewer and shorter down times and almost no maintenance. Filing of incoming and outgoing messages is done electronically on flexible disks, capturing all the benefits for which electronic filing is noted including rapid access, handling ease and space savings. Measurable administrative cost savings are about $1,000 a month. For further information, call or write Sean P. Abercrombie at Ames, Mail Stop 200–25, Mountain View, Calif.

Gerald D. Griffin, Acting Associate Administrator for External Relations at NASA Headquarters and Deputy Director at the Kennedy Space Center, relinquished his Headquarters duties effective June 1 and returned to full-time duty at Kennedy Space Center, Fla. Griffin had served in the dual role since July 7, 1980. Russell Ritchie, the Deputy Associate Administrator for External Relations, will manage the office until a successor is chosen. While at Headquarters, in addition to his External Relations duties, Griffin served as the NASA Transition Officer during the Carter-to-Reagan transition. He also played a key role in planning NASA's external activities related to the first flight of the Space Shuttle.

Contractor News

Fluid Energy Controls, Inc., Orlando, Fla., has been awarded a $1,014,005 fixed-price contract by NASA's Kennedy Space Center, Fla., to supply hypergol and pneumatic panels required in support of Space Shuttle facilities at Kennedy and at Vandenberg Air Force Base, Calif. The contract, made to a small business firm, covers the period from June 5, 1981 to May 3, 1982. At Vandenberg, hypergol panels will be installed at the west coast launch pad for servicing the Space Shuttle systems which burn hypergol fuel. These systems include the engines used to inject the orbiter into its proper orbit and make adjustments to the flight path during the mission. Pneumatic panels supplied to Kennedy will be installed in the Vehicle Assembly Building and Launch Complex 39 launch pads to support pre-launch checkout of the Space Shuttle vehicle and the servicing of Shuttle-carried payloads.

General Electric Co., Lynn, Mass., has been awarded a $5.6 million cost-plus-fixed-fee contract by NASA's Lewis Research Center, Cleveland, for the design, fabrication, and testing of a TF-34 convertible turbofan/shaft aviation engine. The objective of the program, funded jointly by NASA and the Defense Advanced Research Projects Agency, is to explore the technology for integrating turbofan and turboshaft engine capabilities into a single engine. Such an engine could be used in future helicopter and advanced vertical and short-takeoff-and-landing aircraft concepts requiring shaft-driven propulsion for hover and low-speed flight and auxiliary turbofan propulsion for high speed flight. Engine testing will be done at Lewis.

Boeing Services International, Inc., Cocoa Beach, Fla., was awarded a cost-plus-award-fee supplemental agreement to an existing contract with NASA's Kennedy Space Center, Fla., in the amount of $5,075,000 to permit accelerated efforts in support of Space Shuttle launch operations. The contract modification includes the requirement for a seven-day three-shift schedule in support of Space Shuttle processing efforts and covers a period from Oct. 1, 1980 through June 30, 1981. Services performed by the company include the operation and maintenance of ground support equipment such as the crawler transporter, mobile launch platforms and structures, servicing of heating and air conditioning equipment and storage and transfer of rocket propellants.

NASA's Lewis Research Center, Cleveland, has awarded four letter contracts totalling $7,483,000 for the design of a modified Centaur launch vehicle and related components for use on an upper stage with the Space Shuttle. All contracts are in support of the Galileo mission to Jupiter scheduled for launch in 1985 and the International Solar Polar Mission in 1986. **General Dynamics Corp.,** Convair Div., San Diego, Calif., was awarded a $3,412,000 contract to design a modified Centaur vehicle. **Honeywell, Inc.,** Avionics Div., St. Petersburg, Fla., was awarded a $1,593,000 contract for the design and development of the inertial measurement group, a part of the self-contained automatic navigation and guidance system. **Teledyne Industries, Inc.,** Northridge, Calif., was awarded a $1,545,000 contract for the onboard computer and remote multiplexer unit. **United Technologies Corp.,** Pratt & Whitney Aircraft Group, West Palm Beach, Fla., was awarded a $933,000 contract to build RL10A-3-3A rocket engines. Primary thrust for the Centaur is provided by two of these engines which develop 33,000 pounds of total thrust. Lewis manages the Centaur program for the Office of Space Transportation System's Upper Stage Division, NASA Headquarters, Washington, D.C.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
Hardy Charles Svenson, Department of the Treasury, Washington, DC	Liquid or gas cooled flexible beam-compensating adjustable cylindrical mirror	4,266,857	HQS
Charles A. Hoffman, John W. Weeton, and Norman W. Orth, NASA/LeRC	Method of alleviating thermal stress damage in laminates	4,267,953	LeRC
Philip M. Harper, Sr., Boeing Commercial Airplane Co., Seattle, Wash.	Tire/wheel concept	4,267,992	LaRC
W. V. Ruiz and C. S. Thatcher, Rockwell International, Downey, Calif.	Precision heat forming of tetrafluoroethylene tubing	4,269,640	JSC
Robert W. Rosser, Ibrahim M. Shalhoub and Hanoi Kwong, San Jose University, San Jose, Calif.	Bifunctional monomers having terminal oxime and cyano or amidine groups	4,269,787	ARC
Roger B. Michaud, Martin Marietta Aerospace Corp., Denver, Colo.	Urine collection apparatus	4,270,539	MSC
Jose D. Giner and Kathleen J. Cahill, Giner, Inc., Waltham, Mass.	Catalyst surfaces for the chromous, chromic redox couple	4,270,984	LeRC
Thomas N. Canning, Christopher E. Barnes, James P. Murphy, Bobby Gin, and Robert W. King, NASA/ARC	High acceleration cable deployment system	4,271,761	ARC

Expendable Launches for 1981

Name	Launch Date	Vehicle	Range	Mission Remarks
COMSTAR-D	February 21	Atlas Centaur	ESMC	Comsat General Corp. communications. Reimbursable.
GOES-E	May 22	Delta	ESMC	NOAA weather. Reimbursable.
Intelsat V-B	May 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Navy 20 (NOVA 1)	2nd quarter	Scout	WSMC	DOD transit. Reimbursable.
NOAA-C	June 22	Atlas-F	WSMC	NOAA weather. Reimbursable.
Dynamic Explorer	July	Delta	WSMC	NASA scientific.
FLTSATCOM-E	August 6	Atlas Centaur	ESMC	DOD communications. Reimbursable.
SBS-B	August 20	Delta	ESMC	SBS communications. Reimbursable.
Solar Mesospheric Explorer	September 15	Delta	WSMC	NASA scientific.
Intelsat V-C	September	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-D	October	Delta	ESMC	RCA communications. Reimbursable.
NOAA-D	October	Atlas-F	WSMC	NOAA weather. Reimbursable.
RCA-C1	December	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-D	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Navy 21 (NOVA 2)	4th quarter	Scout	WSMC	DOD transit. Reimbursable.

Space Shuttle Launches for 1981

Orbiter	Launch Date	Launch site	Payload
OV-102	April 12	KSC	
OV-102	Sept. 30	KSC	OSTA-1 DFI (with IECM)

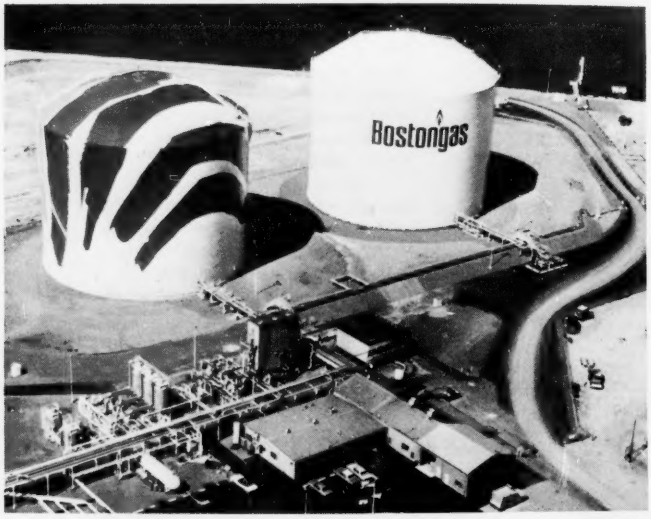
Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Cryogenic Transfer

NASA research on cryogenic cooldown* provided a technology application useful to industry needing to transfer liquefied natural gas from ship to shore and then store it. Liquefied natural gas is a cryogenic fluid which means that it must be contained and transferred at a very low temperatures—about 127 degrees below zero Centigrade. This presented a transfer problem. Before liquefied natural gas can be pumped from a ship to storage tanks, the exchange pipes must be cooled in order to avoid difficulties associated with sharp differences of temperature between the supercold fluid and the relatively warm pipes. Cooldown is accomplished by sending a small, steady flow of the cryogenic substance through the pipeline; the rate of flow must be precisely controlled or the transfer line will be subjected to undesirable thermal stress.

One of the company's needing information on cryogenic cooldown was Chicago Bridge and Iron Co., Oak Brook, Ill. This company found that extensive research on this process had been done by Los Alamos Scientific Laboratory under contract to NASA's Lewis Research Center, Cleveland. Four publications resulting from the rocket research developed under this contract constituted the principal body of available knowledge on cooldown of cryogenic transfer lines. They provided a departure point for the company's own extensive development of cooldown technology and aided in the design and construction of pipeline and storage installations. Shown are the storage tanks and associated piping which are parts of a system operated by Distrigas Corp. in Boston, Mass. This installation is typical of a number of similar systems built by Chicago Iron and Bridge.



* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

For the benefit of all . . .

NASA
National Aeronautics and Space Administration

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